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Spectroscopy and imaging of Zn-air batteries

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Rational exploitation of the energy produced by renewable sources and electromobility, call for the development of efficient and reliable energy storage systems. Batteries are natural candidates for this purpose, and metal-air batteries are expected to gain momentum with respect to Li-ion technologies, because of their potentially higher energy density and sustainability. Among post-Li metal-air systems, Zn-air batteries are especially promising for safety, environmental and cost reasons. Disposable devices are already commercially available, but rechargeable systems are still far from the market, because two key challenges still remain open: on the one hand the optimization of bifunctional catalysts for the reversible air-cathode, that would increase the round-trip efficiency, and, on the other hand, the minimization of anode degradation in both the discharge and charge processes. Even if research is making great efforts in the field, satisfactory grasp of the mechanisms underlying these processes is still lacking. This talk will focus on an approach to the fundamental understanding of a comprehensive range of open issues of Zn-air batteries, based on spectroscopic and imaging methods, with special emphasis on in situ X-ray techniques. Recent results will be expounded, regarding: (i) oxygen catalyst fabrication, operation and degradation, followed by soft-X ray microspectroscopies (SXM) in the direct and Fourier spaces as well as EXAFS; (ii) unstable electrodeposition and dissolution studied in different electrolytes by SXM and photoelectron microspectroscopy; (iii) shape change of Zn anodes investigated by in situ X-ray micro Computed Tomography. This multi-technique approach, combined with mathematical modelling of electrochemical phase formation, opens up new routes for knowledge-based cathode and anode material design and the definition of rational charge/discharge policies.

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